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(56) Documents cited
GB 1472854 A GB 1409711 A GB 1319936 A
GB 1315286 A GB 1286787 A GB 1149064 A

(58) Field of search
UK CL (Edition C) G2J, H4F

(54) Polarisation image detector

(57) A polarisation image detector includes means, for example a double-image prism, for forming respective images of a scene comprising differently polarised radiation components, at least one charge-coupled area imaging array for forming respective video signals corresponding to the polarisation component images, and a signal processing circuit for producing a combined video signal containing information about the polarisation of radiation from the scene.

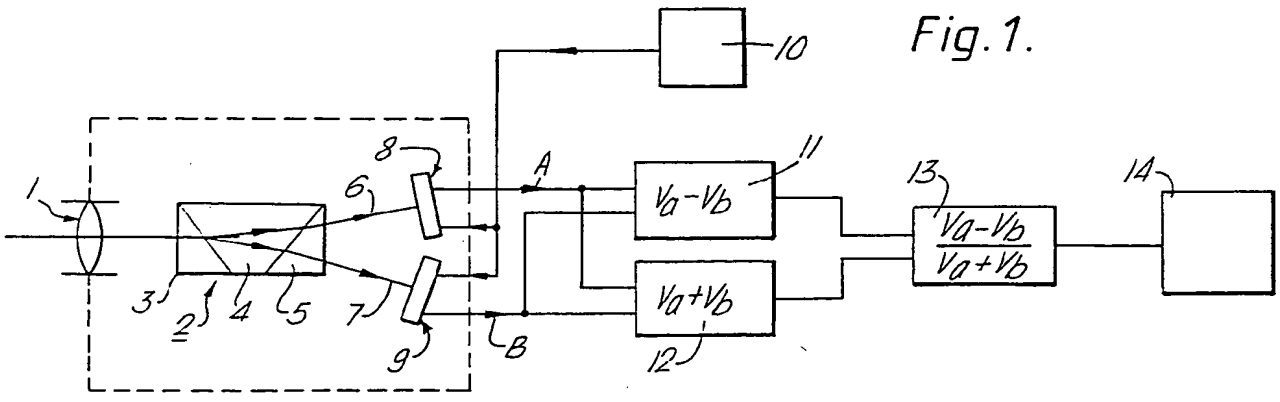

Fig. 1.

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Fig. 1.

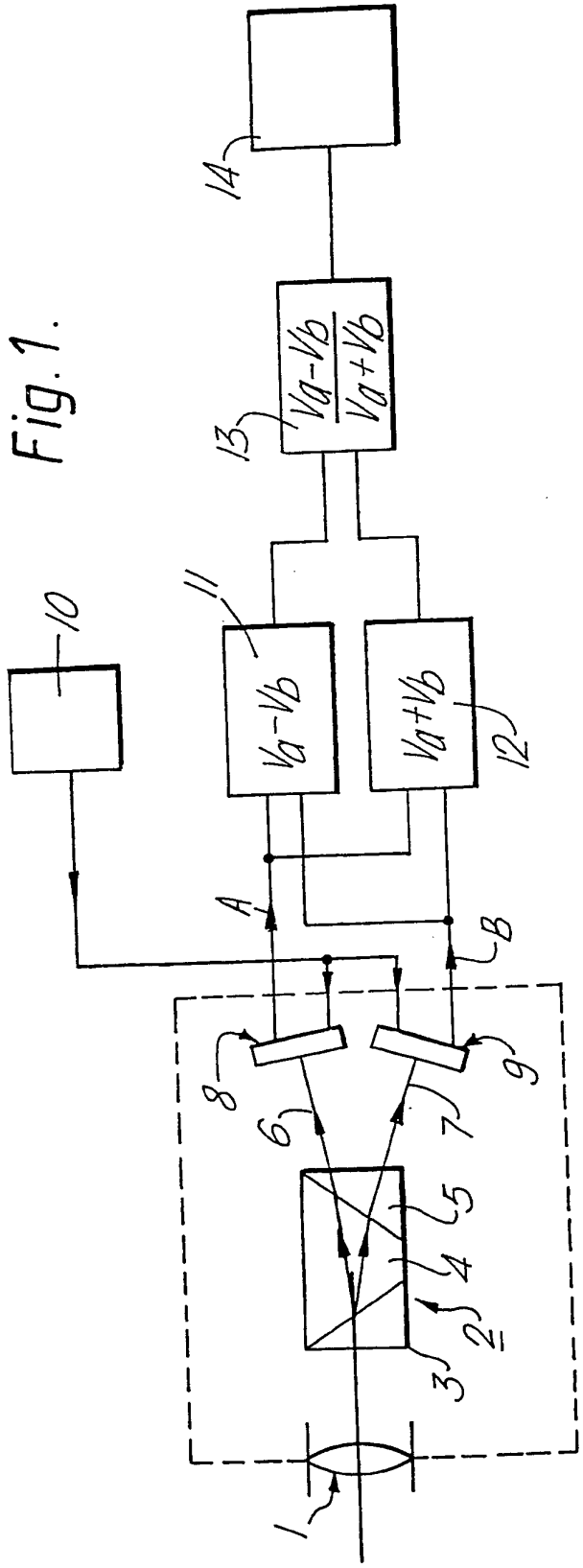
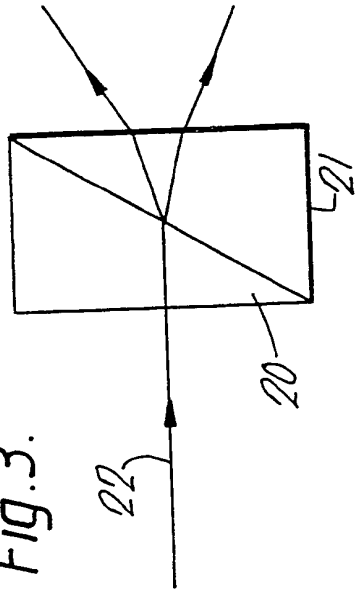


Fig. 3.



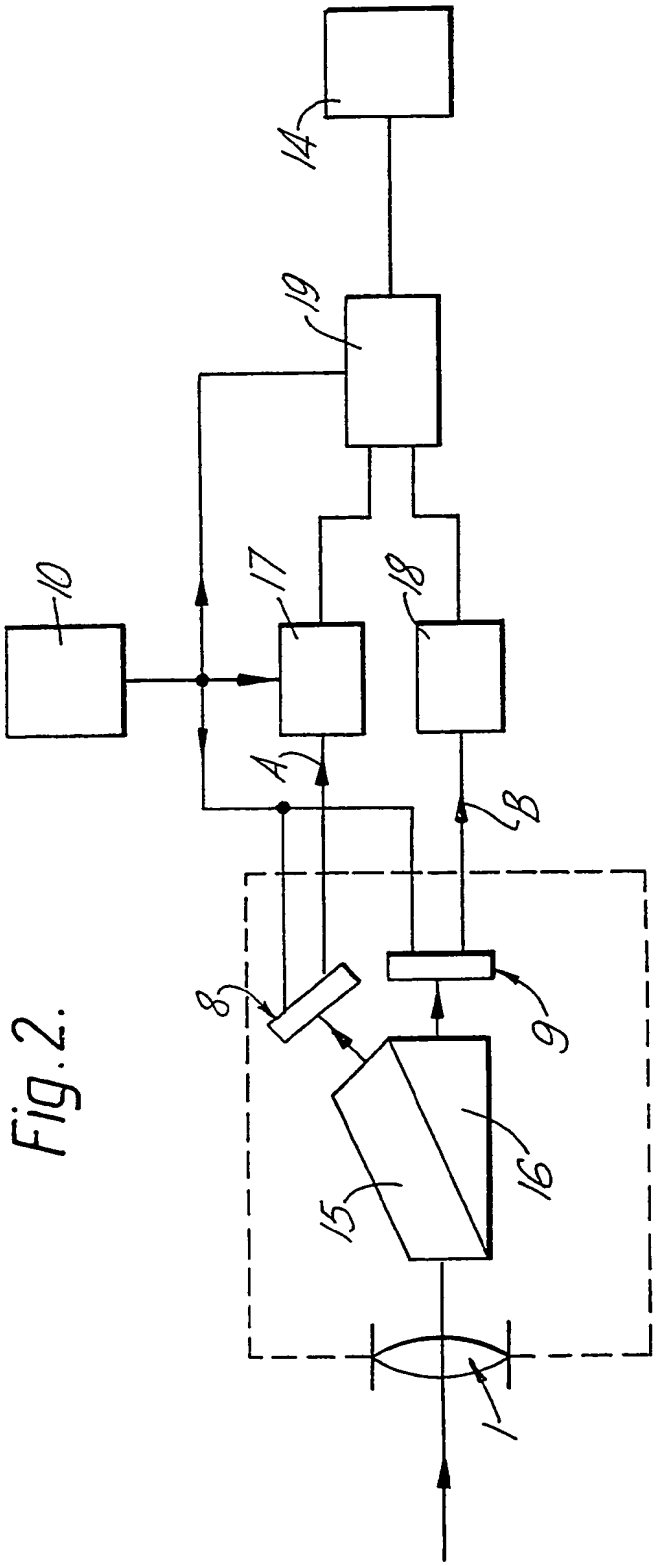


Fig. 2.

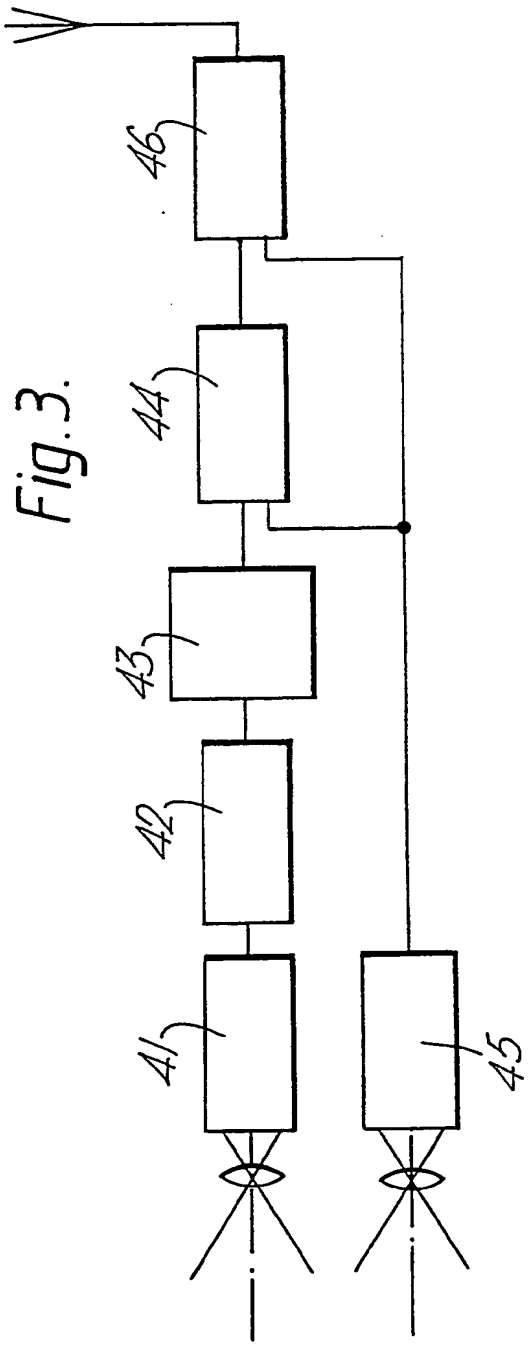


Fig. 3.

Title: Polarisation Image Detection.

A polarisation image detector forms an image signal indicating variations in optical polarisation of light from a scene. When the signal is reproduced as a picture on a t.v. screen, it illustrates surface structure of the scene rather than reflection intensity or colour. The technique may be used in a number of fields, for example in microscopy, medical diagnosis, meteorology and so on.

A polarisation image detector proposed in patent specification No. 1472854 comprises two t.v. camera tubes which receive light via a beam splitter comprising a partially reflecting mirror and via respective polarisers of which the polarising directions are set at right angles to one another. After gamma correction to compensate for non-linearities of the camera system, the video signals are combined to form a polarisation representative picture signal.

Instead of two camera tubes, there can be used a single tube having two separate photo-sensitive screens or there can be used a single camera with a single screen in association with a polariser, e.g. a rotating polarising plate or an electro-optic crystal, operable to change periodically the polarisation direction of the light received by the camera, and with signal delay means operable to bring the image signals obtained during

the respective periods into synchronism.

According to one aspect of the invention there is provided a polarisation image detector comprising means for receiving optical radiation from a scene and for forming images of the scene respectively constituted by radiation components which differ in respect of the polarisation thereof, at least one, but preferably two, charge-coupled area imaging device(s) for forming electrical picture signals corresponding to said images and means for combining said picture signals to form a signal containing information about the polarisation of radiation from the scene.

According to another aspect of the invention there is provided a polarisation image detector comprising means, including a double-image prism, for example a two or three component Wollaston prism or a Glan Thompson prism, for receiving optical radiation from a scene and for forming images of the scene respectively constituted by radiation components which differ in respect of the polarisation thereof, viewing means for forming electrical picture signals corresponding to said images and means for combining said picture signals to form a signal containing information about the polarisation of radiation from the scene.

According to a third aspect of the invention there is provided an air or space vehicle including a

polarisation image detector, preferably a detector in accordance with the first or second aspect of the invention, operable for providing electrical picture signals containing information about the polarisation of optical radiation received from a ground scene.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

figure 1 is a diagrammatic view of the optical system and a simplified circuit diagram of one polarisation image detector,

figure 2 is a similar view of another polarisation image detector,

figure 3 is a side view of a prism, and

figure 4 is a simplified diagram of an airborne target location system.

The detector of figure 1 comprises a focussing system which is represented by the simple lens 1 but which could comprise a more complex system of lenses or be constructed to perform some specialised viewing task, e.g. that of a microscope or telescope. Partially polarised / light entering the focussing system from the scene viewed is incident upon a Wollaston prism 2. A Wollaston prism, or Double Image prism as it is sometimes known, comprises three

cemented-together prism components 3, 4 and 5 made of quartz or calcite. The faces of the components are cut at particular angles such that, as light passes across the interface between two components, it suffers differential refraction, the component of the light polarised in one direction being directed one way and the component polarised in the orthogonal direction being directed another way. As a result the light entering the prism is split to form two beams 6 and 7 polarised at right angles to one another. These two beams are directed towards respective ones of two charge-coupled device area imagers 8 and 9 at the sensing faces of which are formed respective polarised images of the scene viewed. As known, in response to suitable shift signals from a clock generator 10, the devices 8 and 9 output respective picture signals representative of the received images and these picture signals A and B are each fed to both a subtracting device 11, which produces the difference signal A-B, and a summing device 12 which produces the sum A+B. By way of example, the device 11 could comprise a unity gain differential amplifier to the non-inverting and inverting inputs of which are fed the signals A and B respectively, while the device 12 could comprise a unity gain amplifier to which the signals A and B are fed via respective summing

resistors. The outputs from the devices 11 and 12 are fed to a high-speed analogue divider 13, e.g, what is known in the art as a four quadrant transconductance divider, which thus produces an output A-B/A+B. It may be shown that this output displayed on the screen of a t.v. monitor 14, gives only polarisation information about the scene and not about its brightness variations. If desired a digital to analogue converter (not shown) could be interposed between the divider 13 and monitor 14.

Figure 2 illustrates two modifications either or both of which can be made to the figure 1 embodiment. These reside in the prism and the image signal processing circuits. The parts which are unmodified, e.g. the focussing lens system 1, are referenced as before. In figure 2, the Wollaston prism is replaced by another kind of double-image prism which comprises two specially cut, cemented together components 15 and 16 and which is known as a Glan-Thompson prism. The function of the prism is again the same however, i.e, it splits the received light into two beams containing orthogonally polarised components and forms appropriate images at the two charge coupled devices 8 and 9. In response to appropriate shift signals from the clock generator 10, the devices 8 and 9 produce respective picture signals A and B as before but, in this case, these signals are fed to respective analogue to digital converters 17 and

18. The resultant digitally encoded versions of signals A and B are fed to a data processing unit 19 which is programmed to form the combined signal A-B/A+B which, as before, contains information about the polarisation of light from the scene viewed but not its brightness variations and this combined signal is again displayed by a t.v. viewer 14. The operation of the converters 17 and 18 and the data processing unit 19 may be synchronised with that of the devices 8 and 9 by being supplied with signals from the clock generator 10 as shown.

The processing unit 19 may be constituted by a suitably programmed integrated circuit microprocessor. The processing unit may be constructed, e.g. by suitably programming it, if it is a microprocessor or other programmable computing device, to give additional functions such as image enhancement or recognition of particular image patterns. The devices 10, 17 and 18 may also be implemented as integrated circuits. If charge coupled area image devices which provide directly a sufficiently precise digital output are used, the analogue to digital converters 17 and 18 may not be necessary.

It will be appreciated that the illustrated polarisation image detectors using charge coupled devices instead of t.v. cameras can be constructed in a compact

rugged manner, particularly since they are suitable for the image signal processing parts thereof to be implemented by integrated circuit techniques. The devices 8 and 9 in each detector could be combined with the associated prism and perhaps also the lens system and the signal processing units to form a modular unit, for example the devices 8 and 9 could be cemented to appropriately angled faces provided on the prism.

It will be further appreciated that the polarisation image signal is not necessarily fed only to a t.v. viewer or even at all but can be fed to any desired destination equipment, e.g. a video recorder or data processor, and, that, although the production of a picture signal such as one having the form (A-B)/(A+B) which contains only polarisation information is preferred, it is not essential since, for some applications, a simpler signal combination which does vary with brightness of the scene may be adequate.

As a further embodiment (not shown) of the invention, there could be provided a detector comprising a periodically variable polariser, e.g. a rotating plate or an electro-optic crystal polariser in association with a single charge coupled device area imager the signals from which during the respective periods in which the polarisation is different are brought into synchronism by suitable

delay means. In this case, it is preferred that the charge-coupled device signals are converted to, or obtained as, digital signals to facilitate the proper synchronism thereof.

In figure 3 there is shown another form of Wollaston double image prism which may be used in the detectors of figures 1 and 2. This prism comprises two cemented together prism components 20 and 21 and, as with the other prisms, it causes a light beam 22 to be split to form two components polarised perpendicularly to one another.

The polarisation of the light passed to the charge coupled devices in figures 1 and 2 does not have to be linear and at right angles. Instead one or both devices may be arranged to receive, for example, elliptically polarised light which may be of advantage for certain applications.

A polarisation image detector in accordance with the invention could be provided in a manned or unmanned aircraft, spacecraft or a missile for example to locate and identify ground targets either alone or in association with other systems. For example, an airborne installation could comprise a polarisation image detector, a normal visual band t.v. camera and an infra-red imaging system the signals from all of which are fed to on-board recording apparatus or via a radio link to a ground

station. Alternatively, a suitable installation might be as shown in figure 4 where the picture signals from a polarisation detector 41 are fed via digital processing and arithmetic processing units 42 and 43 to a pattern recognition processor unit 44 along with the picture signals from a normal charge-coupled device area imaging system 45. The signals from the pattern recognition device and possibly also the picture signals direct from the system 45 may then be transmitted to a ground station via radio link 46.

A polarisation image detector may also form part of a "contrast lock" missile targeting system. A previously proposed contrast lock system works by illuminating the target with some light source, although this is not always necessary, e.g. during daylight, and a low light television camera operative on say an aircraft, forms an image of the target and surrounding terrain. The missile then takes the camera signal and obtains from it a differential contrast picture. The missile can thus lock onto the target.

This system is not without problems, false detection being particularly common. The application of a polarisation image detector in this application would reduce considerably these false "target locks".

A further application of polarisation image detection might be in radar systems. Obviously the sensors would need to be changed but the technique would remain the same.

WE CLAIM:

1. A polarisation image detector comprising means for receiving optical radiation from a scene and for forming images of the scene respectively constituted by radiation components which differ in respect of the polarisation thereof, at least one, but preferably two, charge-coupled area imaging device(s) for forming electrical picture signals corresponding to said images and means for combining said picture signals to form a signal containing information about the polarisation of radiation from the scene.

2. A polarisation image detector comprising means, including a double-image prism, for example a two or three component Wollaston prism or a Glan Thompson prism, for receiving optical radiation from a scene and for forming images of the scene respectively constituted by radiation components which differ in respect of the polarisation thereof, viewing means for forming electrical picture signals corresponding to said images and means for combining said picture signals to form a signal containing information about the polarisation of radiation from the scene.

3. An air or space vehicle including a polarisation image detector, preferably a detector in accordance with

claim 1 or 2, operable for providing electrical picture signals containing information about the polarisation of optical radiation received from a ground scene.

Amendments to the claims have been filed as follows

1. A polarisation image detector comprising polarising means for receiving optical radiation from a scene and for forming images of the scene respectively constituted by radiation components which differ in respect of the polarisation thereof, two charge-coupled area imaging device(s) for forming electrical picture signals corresponding to said images and means for combining said picture signals to form a signal containing information about the polarisation of radiation from the scene.

2. A polarisation image detector according to claim 1, wherein said polarising means comprises a double-image prism, for example a two or three component Wollaston prism or a Glan Thompson prism.

3. A polarisation image detector according to claim 2, wherein said charge-coupled area imaging devices are fixed to respective surface portions of the prism.

4. A polarisation image detector substantially as hereinbefore described with reference to figure 1, 2 or 3 of the accompanying drawings.

5. An air or space vehicle including a polarisation image detector in accordance with claim 1, 2, 3 or 4,

operable for providing electrical picture signals containing information about the polarisation of optical radiation received from a ground scene.

6. A vehicle substantially as hereinbefore described with reference to figure 4 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number 8125282

Relevant Technical fields

(i) UK Cl (Edition C) H4F (FAA,FCC,FCK,FDX,FJA,FJB,FJC)
G2J (J9)

(ii) Int Cl (Edition) None

Databases (see over)

(i) UK Patent Office

(ii) None

Search Examiner
R C KENNELL

Date of Search
23 NOVEMBER 1981

Documents considered relevant following a search in respect of claims 1-3

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	GB 1472854 (NRDC)	1,2
	GB 1409711 (REDIFON)	1,2
	GB 1319936 (UNION CARBIDE)	1,2
	GB 1315286 (CARL ZEISS JENA)	1,2
	GB 1286787 (FERNSEH)	1,2
	GB 1149064 (INTL RESEARCH & DEVELOPMENT)	1,2

SF2(p)

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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